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【Title of Invention】 AMPLIFYING DEVICE AND X-RAY CT APPARATUS HAVING THREREOF

【Scope of Patent Claims】

【Claim 1】 An amplifying device comprising:

an amplifying means for amplifying electric signals; and

a monitoring means for monitoring an extent of time-dependent change of the electric signals from a Performance characteristic of the amplifying means.

【Claim 2】 The amplifying device according to Claim 1, further comprising a compensating means for compensating the performance characteristic of the amplifying means to a normal performance characteristic when the monitoring means judges that the performance characteristic of the amplifying is lower than a prescribed threshold value.

【Claim 3】 The amplifying device according to either one of Claim 1 or Claim 2, wherein the monitoring means monitors a bias voltage level and/or an amplitude voltage level of the amplifying means.

【Claim 4】 The amplifying device according to either one of Claim 1 through Claim 3, wherein the signals supplied to the amplifying means are electric signals converted through a photoelectric conversion means provided at a front stage of the amplifying means.

【Claim 5】 An amplifying device comprising:

a first amplifying means for amplifying electric signals converted by a photoelectric conversion means;

a first monitoring means for monitoring a bias voltage level of the first amplifying means;

a first compensating for compensating the bias voltage level to a normal voltage level when the first monitoring means judges that the bias voltage level of the first amplifying means is lower than a prescribed threshold value;

a second amplifying means for further amplifying the electric signals amplified in the first amplifying means;

a second monitoring means for monitoring an amplitude voltage level of the second amplifying means; and

a second compensating means for compensating an amplitude voltage level to a normal level when the second monitoring means judges that the amplitude voltage level of the second amplifying means is lower than a prescribed threshold value.

【Claim 6】 An X-ray CT apparatus mounting an X-ray generating means for generating X-rays and an X-ray detecting means for detecting X-rays penetrated through an object on a rotation gantry rotatably supported on a fixed gantry for performing data transmission between the fixed gantry and the rotation gantry through a transmitting means, the X-ray CT apparatus comprising:

a amplifying means for amplifying electric signals of transmitted data through the data transmitting means;

a monitoring means for monitoring an extent of time-dependent change from a performance characteristic of the amplifying means; and

a compensating means for compensating the performance characteristic of the amplifying means to a normal performance characteristic when the monitoring means judges that the performance characteristic of the amplifying is lower than a prescribed threshold value.

【Claim 7】 The X-ray CT apparatus according to Claim 6, wherein the data is X-ray detection data transmitted from the rotation gantry side to the fixed gantry side through the data transmitting means and detected by the X-ray detector, and

wherein the amplifying means, the monitoring means and the compensating means are provided at the data transmitting means side or the fixed gantry side.

【Claim 8】 The X-ray CT apparatus according to either one of Claims 6 or 7, wherein the amplifying means includes a first amplifying means for amplifying the electric signals and a second amplifying means for amplifying an output from the first amplifying means;

the monitoring means includes a first monitoring means for monitoring a bias voltage level of the first amplifying means, and a second monitoring

means for monitoring an amplitude voltage level of the second amplifying means; and

the compensating means includes a first compensating means for compensating the bias voltage level to a normal level when the first monitoring means judges that the bias voltage level of the first amplifying means is lower than a prescribed threshold value, and a second compensating means for compensating an amplitude voltage level to a normal level when the second monitoring means judges that the amplitude voltage level of the second amplifying means is lower than a prescribed threshold value.

【Claim 9】 The amplifying device according to Claim 8, wherein the first compensating means and the second compensating means are operated in synchronization with a prescribed clock signal.

【Claim 10】 The X-ray CT apparatus according to Claims 8, further comprising an alarm means for issuing an alarm when the first monitoring means judges that the bias voltage level of the first amplifying means is lower than the prescribed threshold value and/or the second monitoring means judges that the amplitude voltage level of the second amplifying means is lower than the prescribed threshold value.

【Detailed Description of the Invention】

【0001】

【Field of the Invention】

The present invention relates to an amplifying device for amplifying electric signals and an X-ray CT apparatus having thereof.

【0002】

【Conventional Techniques】

An X-ray CT apparatus acquires tomography images of an object by rotating an X-ray tube and an X-ray detector facing with each other around the object and by measuring penetrated amount of X-rays irradiated from the X-ray tube through the X-ray detector. The measured data is collected in a data collection device as projection data. The collected projection data is performed an image reconstruction process by a computer for generating tomography images. The X-ray tube and the X-ray detector are fixed on a

rotation gantry that is rotatably supported on a fixed gantry. For imaging, the object is placed at a substantial rotation center of the rotation gantry.

In the conventional X-ray CT apparatus (X-ray CT scanner), while data is bi-directionally transmitted between the rotation unit and the fixed unit, the rotation unit is continuously rotated in one direction to achieve a high speed scan, and usually data are transmitted between the rotation unit and the fixed unit through slip rings. However, the conventional X-ray CT apparatus has a reliability problem and a quality problem of data transmission, due to mechanical wear of the slip ring.

To solve these problems, it has been proposed to perform an optical data transmission between the rotation unit and the fixed unit through light emitting elements and light receiving elements (for instance, see Patent Document 1). The transmission lines are provided as a plurality of channels depended on a necessity for bi-directionally transmitting a plurality of data, such as control data of the X-ray tube, position (a rotation angle of the rotation gantry) data, X-ray penetration data, and X-ray detector channel data.

Further, it has been proposed a system for remotely display data of a troubled channel when a trouble is occurred in the X-ray detection system in the X-ray CT apparatus (for instance, see Patent Document 2). Since the system analyses and displays the troubled channel of the X-ray detection system without irradiating X-rays, irradiation exposure can be reduced. This system can reduce a trouble checking operation by a serviceman with visiting at a user even when any trouble has not occurred.

【0003】

【Patent Document 1】

Patent Application Publication H6-261003 (Pages 3-4, Fig. 3)

【Patent Document 2】

Patent Application Publication H9-24044 (Pages 3-5, Fig. 3)

【0004】

【Problems to be solved by the Invention】

Usually, when a trouble occurs during a tomography imaging operation, since the imaging can not be continued, a medical X-ray CT apparatus becomes impossible to appropriately diagnose or treat a patient.

However, the above-described conventional X-ray CT apparatus suggests only to remotely transmit data of the troubled channel and to display the

troubled portion. As a result, when a trouble occurs, the apparatus can not be used until when a serviceman completes repair operation of the troubled Portion.

The present invention intended to solve the above-described problems, and to provide an apparatus that can maintain normal operations until a serviceman arrive, even when a trouble occurs in the apparatus.

【0005】

【Means for solving the Problems】

To solve the above-described problems, the invention described in Claim 1 is characterized in that an amplifying device includes an amplifying means for amplifying electric signals, and a monitoring means for monitoring a performance characteristic of the amplifying means.

According to this feature, it becomes possible to take a measurement or to prepare for a trouble before an occurrence of the trouble in the apparatus.

The invention described in Claim 2 is characterized in that the amplifying device according to Claim 1 further includes a compensating means for compensating the Performance characteristic of the amplifying means to a normal performance characteristic, when the monitoring means judges that the Performance characteristic of the amplifying means is lower than a prescribed threshold value.

According to this feature, the amplifying device can be operated as a usual during a maintenance operation by a serviceman.

The invention described in Claim 5 is characterized in that an amplifying device includes a first amplifying means for amplifying electric signals converted by a photoelectric conversion means, a first monitoring means for monitoring a bias voltage level of the first amplifying means, a compensating first means for compensating the bias voltage level to a normal level when the first monitoring means judges that the bias voltage level of the first amplifying is lower than a prescribed threshold value, a second amplifying means for amplifying the electric signals amplified by the first amplifying means, a second monitoring means for monitoring an amplitude voltage level of the second amplifying means, and a second compensating means for compensating the amplitude voltage level to the normal level when the second monitoring means judges that the amplitude voltage level of the second amplifying means is lower than a prescribed threshold value.

According to this feature, the amplifying device can be normally operated during when a maintenance operation for a trouble is performed by a serviceman. As a result, it can avoid such an inconvenience that an operating apparatus including the amplifying device needs to unwontedly stop.

【0006】

The invention described in Claim 6 is characterized in that an X-ray CT apparatus includes an X-ray generating means for generating X-rays and an X-ray detection means for detecting X-rays penetrated through an object that are rotatably supported on a rotation gantry that is supported on a fixed gantry for transmitting data between the fixed gantry and the rotation gantry through a data transmitting means. The X-ray CT apparatus includes an amplifying means for amplifying electric signals relating the data transmitted through the data transmitting means, a monitoring means for monitoring a time-dependent change extent of the performance characteristic of the amplifying means, and a compensating means for compensating the performance characteristic of the amplifying means to a normal performance characteristic when the monitoring means judges that the performance characteristic of the amplifying means is lower than a prescribed threshold value.

The invention described in Claim 7 is further characterized in that the data used in the X-ray CT apparatus of Claim 6 is X-ray detection data detected by the X-ray detector during transmitting from the rotation gantry side to the fixed gantry side. And the amplifying means, the monitoring means and the compensating means are provided on the transmitting means side or the fixed gantry side.

The invention described in Claim 8 is characterized in that the amplifying means in the X-ray CT apparatus of Claim 7 includes a first amplifying means for amplifying the electric signals and a second amplifying means for amplifying an output of the first amplifying means; the means for monitoring includes a first monitoring means for monitoring a bias voltage level of the first amplifying means and a second monitoring means for monitoring an amplitude voltage level of the second amplifying means; and the means for compensating includes a first compensating means for compensating the bias voltage level to a normal level when the first monitoring means judges that the bias voltage level of the first amplifying means is lower than a prescribed threshold value and a second compensating

means for compensating the amplitude voltage level to a normal level when the second monitoring means judges that the amplitude voltage level of the second amplifying means is lower than a prescribed threshold value.

【0007】

According to these features, it becomes possible to operate the X-ray CT apparatus as a usual during maintenance operations of a troubled portion by a serviceman. Consequently, inconveniences such as suspension of imaging and diagnosis due to a stop of the operating X-ray CT apparatus are avoided.

【0008】

The invention described in Claim 9 is characterized in that the first compensating means and the second compensating means in the X-ray CT apparatus of Claim 8 are operate in synchronization with prescribed clock signals.

According to this feature, even when the data is transmitted in a high speed, different kinds of compensating operations to each of different amplifying means can certainly achieve in accordance with data transmission timings.

The invention described in Claim 10 is characterized in that the X-ray CT apparatus Claim 9 further includes an alarm means for issuing an alarm when the first monitoring means judges that the bias voltage level of the first amplifying means is lower than a prescribed threshold value and/or the second monitoring means judges that the amplitude voltage level of the second amplifying means is lower than a prescribed threshold value.

According to this feature, it becomes possible to easily identify a troubled amplifying means in the X-ray CT apparatus. As a result, a quick measurement can be performed.

【0009】

【Embodiments of the Invention】

Referring Figs.1 through 6, an exemplary embodiment of the amplifying device and the X-ray CT apparatus having thereof consistent with the present invention is explained. In the following explanation, it is supposed that the amplifying device is provided in a transmission system for transmitting control data and X-ray penetration data between the rotation unit and the fixed unit in the X-ray CT apparatus.

Fig. 1 is an outside view illustrating construction of the exemplary embodiment of the X-ray CT apparatus consistent with the Present invention. Fig. 2 is a block diagram for illustrating the X-ray CT apparatus.

The X-ray CT apparatus is comprised of a fixed gantry 1, a bed 2 provided in front of the fixed gantry 1 and an operation table 3 for operating the fixed gantry 1 and the bed 2 and for totally controlling each units in the X-ray CT apparatus. In a substantial center portion of the fixed gantry 1, an aperture 4 is provided for constructing an imaging portion. On an upper surface of the bed 2, a top plate 5 is provided for supporting an object. By operating the operation table 3, a height of the bed 2 is suitably adjusted and the top plate 5 is slid in the fixed gantry 1 side. Thus, during imaging operation, the object supported on the top plate 5 is inserted into the aperture 4 of the fixed gantry 1.

On the operation table 3, input devices 6, such as a keyboard, mouse and pointing devices of a track ball and a joy stick, and a monitor 7 are provided. As explained later, a control unit 20 is placed in the operation table 3,

【0010】

A rotation gantry 13 is rotatably supported in the fixed gantry 1. In the rotation gantry 13, as illustrated in Fig. 2, an X-ray tube 11 and an X-ray detector 12 are fixed so as to face with each other through an object P positioned in the aperture 4 by supporting on the top plate 5. From a focus point of the X-ray tube 11, a cone shaped X-ray beam is irradiated. A slit (not shown) is provided at an X-ray irradiation aperture in order to reform the cone shaped X-ray beam to a desired size and irradiate onto the object P as a fan-shaped X-ray beam. The X-rays penetrated through the object P are detected by a one dimensional array X-ray detector 12 in which a plurality of detection elements are arranged in a linear. Of course, it is possible to use a two-dimensional array X-ray detector 12 in which a plurality of one dimensional X-ray detectors are arrayed along a width direction.

Since the X-ray tube 11and the X-ray detector12 are fixed on the rotation gantry 13, they are continuously rotated around an object P together with the rotation gantry 13. The rotation gantry 13 is driven a rotation drive unit 14 based on drive control signals supplied from the control unit 20. A bed control unit 15 is provided on the bed 2 in order to; for instance, intermittently move the top plate 5 to a desired slice position by a certain

amount based on bed control signals supplied from the control unit 20, or to continuously move the top plate 5 in a prescribed scanning scope.

【0011】

The X-ray tube 11 fixed to the rotation gantry 13 is connected to a high voltage generator 16. The high voltage generator 16 determines a tube current and a tube voltage supplied to the X-ray tube 11 based on X-ray control signals supplied from the control unit 20, and generates X-rays at a prescribed timing.

A data acquisition system (hereinafter, DAS) 17 is connected to the X-ray detector 12 fixed to the rotation gantry 13. The DAS 17 collects projection data reflected X-ray penetration ratio of the respective X-ray paths obtained from the X-ray detector 12 based on data acquisition control signals supplied from the control unit 20 at the X-ray generation timing. While a showing is omitted, the DAS 17 includes an integrator for temporally integrating an output from each of X-ray detection elements in the X-ray detector 12 and an A/D converter for converting outputs from the integrator to digital signals.

【0012】

Fig. 3 illustrates an amplifying device provided in a data transmission system for bi-directionally transmitting data between the fixed gantry 1 and the rotation gantry 13 in the above-mentioned X-ray CT apparatus. Here, in the present embodiment, the data transmission system for transmitting data between the fixed gantry 1 and the rotation gantry 13 is supposed as a non-contact light transmission.

Fig. 3 is a block diagram illustrating an exemplary embodiment of an amplifying device consistent with the present invention. The amplifying device 30 includes a light reception circuit 40, a clock circuit 50, a bias voltage control circuit 60 and an amplitude voltage control circuit 70.

The light reception circuit 40 includes photoelectric conversion elements 41, such as photodiodes, a preamplifier 42 for amplifying weak electric signals obtained from the photoelectric conversion element 41 and a limiting amplifier 43 for generating signals of prescribed amplitude by amplifying signals obtained from the preamplifier 42. The photoelectric conversion elements 41 receive light signals emitted from electric-photo conversion elements for converting electric signals to light signals, such as laser diodes, and convert to electric signals. The converted electric signals are transmitted, for example, in a speed of 500 Mbps.

The clock circuit 50 generates clock signals in synchronization with clock signals included in original data received by the photoelectric conversion element 41. The generated clock signals are used to match operation timings of a later explained compensation circuit.

The bias voltage control circuit 60 includes a bias voltage level monitor 61 for monitoring a bias voltage level of the preamplifier 42, a bias level correction circuit 62 f or maintaining the bias voltage level at a level of normal operation time by applying a positive feedback to the bias circuit of the preamplifier 42 when the monitored bias voltage level of the preamplifier 42 is lower than a prescribed threshold value, and an alarm 63 for issuing an alarm when the bias voltage level monitor 61 judges that the bias voltage level of the preamplifier 42 is lower than the prescribed threshold value.

The amplitude voltage control circuit 70 includes an amplitude voltage level monitor 71 for monitoring the an amplitude voltage level of an input side of the limiting amplifier 43, an amplitude level correction circuit 72 for maintaining the amplitude voltage level at a level of normal operation time by applying a positive feedback to the input side of the limiting amplifier 43 when the monitored amplitude voltage level of the limiting amplifier 43 is lower than a prescribed threshold value, and an alarm 73 for issuing an alarm when the bias voltage level monitor 61 judges that the an amplitude voltage level of an input side of the amplitude voltage level monitor 71 is lower than the prescribed threshold value.

【0013】

Next, operations of the amplifying device 30 are explained.

For instance, supposed that a light reception circuit 40 is provided the fixed gantry 1 side of the X-ray CT apparatus, the photoelectric conversion element 41 receives light signals emitted from electro-photo conversion elements (not shown) provided the rotation gantry 13 side of the X-ray CT apparatus. In the light reception circuit 40, as an usual signal flow, the received photo signals are converted into electric signals in the photoelectric conversion element 41 (step 1), the converted electric signals are amplified by supplying to the preamplifier 42 (step 2),and the output of the preamplifier 42 is further amplified in the limiting amplifier 43 (step 3). The limiting amplifier 43 issues a signal of a prescribed level for supplying to the next stage of a control circuit or a drive circuit. These signal flows are illustrated in Fig. 4.

It is, of course, possible to provide the light reception circuit 40 at the rotation gantry side. In that case, the light reception circuit 40 receives light signals emitted from the fixed gantry side and similarly operates as provided at the fixed gantry side.

【0014】

Under a normal operation of the light reception circuit 40, it may happen that the preamplifier 42 and the limiting amplifier 43 deteriorate its performance characteristics in accordance with time-dependent changes. If such deteriorations of the performance characteristics occur, the preamplifier 42 cannot obtain prescribed amplitude, since the bias voltage level becomes lower than the prescribed threshold value. Similarly, the limiting amplifier43 also cannot obtain prescribed amplitude since the input level reduces due to deterioration of the performance characteristics.

According to the present invention, the changing status of the performance characteristics of the preamplifier 42 and the limiting amplifier 43 are monitored. And when it is judged that the performance characteristic is lower than a prescribed threshold value, an alarm is issued. Further, the deterioration of the performance characteristic is taken an emergency measure so as to temporarily keep the prescribed performance characteristic.

【0015】

Figs. 3 and 5 are flowcharts illustrating operations of the amplifying device 30 consistent with the present embodiment.

The light signals from the electro-photo conversion elements (not shown) are received at the photo-electric conversion element 41 for converting the light signals to electric signals (step 11). The converted electric signals are supplied to and amplified at the preamplifier 42 (step 12). A bias voltage level of the preamplifier 42 is constantly monitored by the bias voltage level monitor 61 (step 13). As a result of the monitoring, if the bias voltage level of the preamplifier 42 is larger than a prescribed threshold value (YES), outputs of the preamplifier 42 are supplied to and amplified at the limiting amplifier 43 to obtain output signals of a prescribed amplitude (step 14).

On the contrary, as a result of monitoring by the bias voltage level monitor 61, if it is judged that the bias voltage level of the preamplifier 42 is lower than the prescribed threshold value (NO), the bias level correction circuit 62 operates so as to take a positive feedback to the bias circuit of the

preamplifier 42 so as to keep the bias voltage level at a normal operation time level (step 15). In the step 13,if the bias voltage level monitor 61 judges that the bias voltage level of the preamplifier 42a is lower than the prescribed threshold value (NO), the alarm 63 is operated and issue an alarm (step 16). The operations of the alarm 63 includes lighting an indicator, issuing alarm sound or transmitting signals to a remote monitoring center.

【0016】

The amplitude voltage level at an input side of the limiting amplifier 43 is also constantly monitored by the amplitude voltage level monitor 71 (step 17). As a result of monitoring, if the amplitude voltage level is larger than a prescribed threshold value (YES), the limiting amplifier 43 issues output signals of a prescribed level to a control circuit or a drive circuit at a next stage.

On the contrary, as a result of monitoring by the amplitude voltage level monitor 71, if it is judged that the amplitude voltage level at an input side of the limiting amplifier 43 is lower than the prescribed threshold value (NO), the amplitude level correction circuit 72 operates so as to take a positive feedback to an input circuit of the limiting amplifier 43 and keeps the amplitude voltage level of the input side at a normal operation time level (step 18), so as to obtain the output signals of the prescribed level. In the step 17, if the amplitude voltage level monitor 71 judges that the amplitude voltage level at the input side of the limiting amplifier 43 is lower than a prescribed threshold value (NO), the alarm 73 is operated and issues an alarm (step 19). As similar to the alarm 63, the operations of the alarm 73 includes lighting an indicator, issuing alarm sound or transmitting signals to a remote monitoring center.

The transmitting signals transferred through the photoelectric conversion element 41 are synchronized with prescribed clock signals. Accordingly, it needs to adjust timing of signals corrected by the bias level correction circuit 62 and the amplitude level correction circuit 72. Since the clock signals are included in the transmitting data, the clock circuit 50 issues clock signals synchronized with the clock signals included in the original data received by the photoelectric conversion element 41. The clock signals are supplied to the bias level correction circuit 62 and amplitude level correction circuit 72 to coincide its operation timings.

【0017】

According to the present exemplary embodiment, it becomes possible to know the deteriorations of the characteristics of the active elements constructing the amplifying device 30 across the ages at an earlier stage.

When the reduction of the characteristics becomes lower than a threshold value, an alarm is issued. Consequently, it becomes possible to quickly take necessary measurements, such as replacements of components or repairs by a serviceman. Further, during measuring operations by the serviceman, the X-ray CT apparatus can be continuously used since both the bias level correction circuit 62 and the amplitude level correction circuit 72 operate so as to keep the amplifying device 30 at the normal operation status as an emergency step. Consequently, even when the reduction of the characteristic may occur during imaging of a patient, the imaging can be continued and can avoid an increase of X-ray exposure by repeating the same imaging.

In a case that a plurality of amplifying devices 30 consistent with the present embodiment in a plurality of transmission systems, it can easily distinguish a particular amplifying device 30 reduced characteristics by providing the alarm 63 and the alarm 73 so as to light up the respective LED (light emitting diode). Thus, the following maintenance operation by a serviceman can be easily performed. Of course, it is possible to collectively provide the alarms 63 and 73 for the plurality of amplifying devices on a console of the X-ray CT apparatus.

【0018】

Usually, various kinds of medical equipments, such as an X-ray CT apparatus and a magnetic resonance imaging instrument (MRI), are placed in a medical site, such as a hospital. For instance, as depicted in a system diagram in Fig. 6, in each of a plurality of medical sites 100, 110, ··· , different kinds of medical units 100A(CT), 100B(MRI), ···,and 110A(CT), 110B(MRI), ··· are respectively installed. These different kinds of medical units in the respective medical site are connected to a service center 200 located in the medical site or a remotely located service center 200 through a network 300 for performing maintenance or management operations. In such a case, it may transfer data from the alarms 63 or 73 to the remote service center 200 through the network.

【0019】

The present invention does not limited to the above described exemplary embodiments, and various modifications can be applicable. For instance,

while the amplifying device 30 is described as a device provided in an X-ray CT apparatus, it is applicable to various apparatus other than the X-ray CT apparatus. Of course, such applicable apparatus does not limited to medical instruments. The transmitted signals are not limited to the electric signals converted through the photoelectric conversion elements from the light signals, but the electric signals converted from pressures, such as hydraulic pressure or wind pressure, and vibrations. Further, the signals need not to be transmitted by a non-contact. It is available to use the conventional mechanical means such as a slip ring.

If an enlargement of a mount space or an increase of the cost is permitted, an auxiliary preamplifier or an auxiliary limiting amplifier can be prepared so as to continuously use the amplifying device 30 in a usual state by changing them when the amplitude level or the bias voltage level is judged as lower than a prescribed threshold value.

【0020】

【Effects of the Invention】

As explained the above, according to the invention described in Claim 1, the deterioration of the characteristics of the active elements constructing the amplifying device due to secular changes can be identified at an early stage. Thus, it becomes possible to take a measurement before a trouble occurs in the apparatus.

According to the invention described in Claim 2, since the amplifying device can be kept in a usual operation state during a maintenance operation by a serviceman, the apparatus having the amplifying device can be continuously used in a certain period as an emergency use.

Further, according to the invention described in Claim 5, it becomes possible to preliminarily measure or prepare a trouble before appearance of the trouble. Even when a serviceman is performing maintenance operations, the amplifying device can be operated as a usual. Consequently, such inconvenience as that the apparatus having the amplifying device is unwontedly stopped can be avoided.

【0021】

Further, according to the invention described in Claims 6 through 8, the X-ray CT apparatus can be usually operated during when a maintenance operation of a troubled portion is performed by a serviceman. Consequently,

such inconveniences due to suspensions of imaging or examination by stopping the operating X-ray CT apparatus are avoided.

According to the invention described in Claim 9, when the data is transmitted in a high speed, it becomes possible to certainly perform different correction operations to each of different amplifying means with matching to the data transmission timings.

According to the invention described in Claim 10, it becomes possible to easily identify a troubled amplifying means or a troubled content and to quickly take measures.

【Brief Explanation of Drawings】

【Fig. 1】

An appearance diagram illustrating an exemplary embodiment of the X-ray CT apparatus consistent with the present invention.

【Fig. 2】

A block diagram illustrating an exemplary embodiment of the X-ray CT apparatus consistent with the present invention.

【Fig. 3】

A block diagram illustrating an exemplary embodiment of the amplifying device consistent with the present invention.

【Fig. 4】

A flowchart depicting signals flows in the amplifying device consistent with the exemplary embodiment.

【Fig. 5】

A flowchart illustrating operations of the amplifying device consistent with the exemplary embodiment.

【Fig. 6】

A block diagram illustrating an exemplary application of the amplifying device and the X-ray CT apparatus having thereof consistent with the exemplary embodiment.

【Explanation of symbol】

30 amplifying device
40 light reception circuit
41 Photoelectric conversion element
42 Preamplifier
43 limiting amplifier
50 clock circuit

60 bias voltage control circuit
61 a bias voltage level monitor
62 bias level correction circuit
63 alarm
70 amplitude voltage control circuit
71 an amplitude voltage level monitor
72 amplitude level correction circuit
73 alarm

【Document Name】 ABSTRACT

【Abstract】

【Problems to be solved】 To solve an inconvenience that an apparatus can not be used until finishing a repairing operation when a trouble occurs.

【Solution】 The apparatus includes a preamplifier 42 for amplifying electric signals, a bias voltage level monitor 61 for monitoring performance characteristics of the preamplifier and a bias level correction circuit 62 for holding the bias voltage level of the preamplifier at a normal operational level when the bias voltage level monitor judges that the performance characteristic of the preamplifier is lower than a prescribed threshold value.

As a result, it becomes possible to preliminarily take measurement for a trouble before an occurrence of the trouble. Further the apparatus can be normally operated during a maintenance of the apparatus is operated by a serviceman.

【Selected Drawing】 Fig. 3